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# अतप्त लघुकृत कार्बन इस्पात की चादर एवं पत्ती

भाग 1 कोल्ड फॉर्मिंग एवं ड्राइंग के लिए  
(छठा पुनरीक्षण)

## Cold Reduced Carbon Steel Sheet and Strip

Part 1 Cold Forming and Drawing Purpose  
(Sixth Revision)

ICS 77.140.50

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## FOREWORD

This Indian Standard (Part 1) (Sixth Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Wrought Steel Products Sectional Committee had been approved by the Metallurgical Engineering Division Council.

This standard was first published in 1954 and revised in 1963, 1973, 1986, 1994 and 2008. While reviewing this standard, in the light of experience gained during these years, the Committee decided to revise it to bring in line with the present manufacturing and trade practices being followed in the country in this field.

This standard is published in two parts. The other part in the series is:

### Part 2 High tensile and multi-phase steel

With the constant requirement of greater, stringent and varied requirements for steel sheets and strips for automobile industry and engineering applications, many specifications were made. An endeavour is made to identify, summarize and create a new standard. An attempt is made to cover all such requirements of Automobile and Engineering application under a single standard. However, interested parties as per their requirement may apply more stringent requirement against any clause in this standard or specify other characteristics not covered by this standard.

In the present version following modifications are made:

- a) New designations and grades are added ;
- b) Existing standard is divided into two parts, based on the strength level;
- c) Classification of grades has been added;
- d) New designations have been added in temper designations;
- e) Non-ageing characteristics have been modified;
- f) Correlation of old designation with new designations and grades has been given for information (*see Annex A*);
- g) Tables for chemical composition, variation in product analysis and mechanical properties are changed as per the new designations and grades;
- h) Clauses on mechanical and physical properties, surface finish, freedom from defects and dimensions and tolerances have been modified; and
- j) References in normative references have been updated.

Assistance has been derived from the following:

ISO 3574	Cold reduced carbon steel sheet for commercial and drawing qualities
EN 10268	Cold rolled steel flat products with high yield strength for cold forming
JFS A 2001	Cold-rolled steel sheet and strip for automobile use
JIS G 3135	Cold reduced high strength steel sheet and strip with improved formability for automobile structural uses

For the purpose of deciding whether a particular requirement of this standard is complied with the final value, observed or calculated, expressing the result of a test or analysis shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

*Indian Standard*

# COLD REDUCED CARBON STEEL SHEET AND STRIP

## PART 1 COLD FORMING AND DRAWING PURPOSE

( *Sixth Revision* )

**1 SCOPE**

This standard (Part 1) covers the requirements of cold reduced carbon steel sheets and strips for cold forming and drawing purpose and where the surface is of prime importance. It covers sheets and strips up to 4.0 mm thick both in coil form and cut lengths.

**2 REFERENCES**

The following standards contain provisions which through in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below.

<i>IS No.</i>	<i>Title</i>
228 (Relevant Parts)	Method for chemical analysis for steel
1501 (Parts 1 to 4) : 2013	Metallic materials — Vickers hardness test ( <i>fourth revision</i> )
1586 (Part 1 to 3) : 2012	Metallic materials — Rockwell hardness test ( <i>fourth revision</i> )
1599 : 2012	Metallic Materials — Bend test ( <i>third revision</i> )
1608 : 2005	Metallic material — Tensile testing at ambient temperature ( <i>third revision</i> )
1956 (Part 4) : 2013	Glossary of terms relating to iron and steel: Part — 4 Flat products ( <i>second revision</i> )
8910 : 2010	General technical delivery conditions of steel and steel products
10175 : 2012	Metallic materials — Sheet and strip—Erichsen cupping test
11999 : 2007	Method for determination of plastic strain ratio 'r' for sheet metals
15262 : 2002	Geometrical product specifications (GPS)— Surface texture: Profile method — Terms, definitions and surface texture parameters

*IS No.**Title*

15756 : 2007	Metallic materials — Sheet and strip — Determination of tensile strain hardening exponent
IS/ISO 16162 : 2012	Cold-rolled steel sheet products — Dimensional and shape tolerances ( <i>first revision</i> )

**3 TERMINOLOGY**

**3.1** For the purpose of this standard the definitions given in IS 1956 (Part 4) shall apply.

**3.2 Classification of Grades**

Sheets and strips shall be classified as per the following groups and designated as per Table 1.

**3.2.1 Cold Rolled Full Hard**

Cold rolled full hard steel strips, which can be used in the production of cold rolled annealed steel/ Galvanized steel/Galvanneal steel/any other process/directly used in general engineering purpose.

**3.2.2 General Purpose (CR)**

Steels which are used in general engineering applications where light bending or forming is required.

**3.2.3 Drawing Quality (C,D,E,F,G)**

Mild steels which are used for the purpose of drawing, where as per the grade, light to critical drawing applications are involved.

**3.2.4 Interstitial Free-High Strength Steel (P)**

Interstitial free steels having excellent drawing capabilities for cold forming applicability. Strengthening by solid solution hardening.

**3.2.5 Bake Hardening (B)**

Steels that exhibit increase in proof stress following paint baking treatment. Steel exhibit good drawing capabilities before forming and increase in strength after paint baking process for dent resistant applications.

**Table 1 Designation and Grades**  
(Clause 3.2)

Designation (Quality) (1)	Grade (2)	Available Product Range, mm (3)
Cold Rolled (Full Hard)	CR0	0.08-4.00
General Purpose	CR1	0.08-4.00
	CR2	0.20-4.00
	CR3	0.20-4.00
	CR4	0.30-4.00
	CR5	0.30-4.00
Drawing Quality	ISC270C	0.20-3.20
	ISC270D	0.20-3.20
	ISC270E	0.20-3.20
	ISC270F	0.40-3.20
	ISC260G	0.40-2.30
Interstitial Free-High Strength steel	ISC340P	0.40-2.30
	ISC370P	0.40-2.30
	ISC390P	0.40-2.30
	ISC440P	0.40-2.30
Bake Hardening	ISC270B	0.40-2.30
	ISC300B	0.40-2.30
	ISC320B	0.40-2.30
	ISC340B	0.40-2.30
	ISC360B	0.40-2.30
	ISC390B	0.40-2.30
	ISC440B	0.40-2.30
Re-Phosphorized	ISC280R	0.40-3.00
	ISC320R	0.40-3.00
	ISC360R	0.40-3.00
	ISC400R	0.40-3.00
C,Mn Steel	ISC340W	0.40-3.00
	ISC370W	0.40-3.00
	ISC390W	0.40-3.00
	ISC440W	0.40-3.00

## NOTES

**1** For any thickness greater than or less than the mentioned range, the same can be produced as mutually agreed to between the manufacturer and the purchaser. Acceptance criteria for the range out of available product range shall be as agreed to between the purchaser and the manufacturer.

**2** For general purpose designation, grade qualities are as follows CR1 — Commercial, CR2 — Drawing, CR3 — Deep drawing, CR4 — Extra Deep drawing, CR5 — Extra deep drawing (Stabilized interstitial free).

**3** Nomenclature of grade is explained in Annex C.

**3.2.6 Re-Phosphorized (R)**

Steel exhibit good impact and fatigue strengths. Steels that contain phosphorus to achieve the required strength.

**3.2.7 C,Mn Steel (W)**

Steel exhibit high strengths with relatively lower yield stress. Steel that is strengthened by the addition of Carbon and Manganese, to achieve the

required strength. (Minimum tensile strength less than or equal 440 MPa.)

**4 SUPPLY OF MATERIAL**

**4.1** General requirements relating to the supply of cold rolled carbon steel sheets and strip shall conform to IS 8910.

**4.2** Sheets and strips may be supplied either with mill or trimmed edges.

**4.3** Sheets and strips of CR1 may be supplied in any of following tempers. Sheets and strips of grades other than CR1 (excluding CR0, which is supplied in full hard condition) shall be supplied in annealed-skin passed or, as agreed to between the manufacturer and the purchaser.

<i>Temper Designation</i>	<i>Temper</i>	<i>Processing</i>
(1)	(2)	(3)
1/2 H	Half Hard	Produced by cold rolling followed by annealing and further cold rolling to give strip of intermediate hardness
1/4 H	Quarter Hard	-do-
1/8 H	1/8 Hard	-do-
SP	Skin Passed	Produced by light cold rolling after annealing
A	Annealed	Produced by a final annealing process

For specific applications, sheets and strips may also be supplied in any other temper conditions subject to agreement between the manufacturer and the purchaser. For such temper grades and as annealed conditions, mechanical properties shall be as agreed to between the manufacturer and the purchaser.

## 5 NON-AGEING CHARACTERISTICS

**5.1** The manufacturer shall guarantee the absence of stretcher strains on being cold worked in the case of non-ageing quality with a non-ageing guarantee for six months from the date of manufacture (Date of skin pass), when stored at room temperature.

**5.2** The manufacturer shall guarantee the absence of stretcher strains on being cold worked in the case of delayed-ageing quality with a non-ageing guarantee for three months from the date of manufacture (Date of skin pass), when stored at room temperature.

**5.3** Non-ageing characteristics of sheets and strips shall be as per Table 2.

## 6 MANUFACTURE

**6.1** The method of manufacture of steel and subsequent processing for production of steel for sheets and strips shall be left at the discretion of the manufacturer or as agreed to between the manufacturer and the purchaser.

**6.2** Sheets and strips shall be supplied rimmed, semi-killed or fully killed as agreed to between the manufacturer and the purchaser. Grades which are

**Table 2 Non-Ageing Characteristics**  
(Clauses 5.3 and 8.1.2)

<b>Grade</b>	<b>Non-Ageing Characteristics</b>
(1)	(2)
CR0	—
CR1	—
CR2	8 days
CR3	8 days
CR4	Non Ageing
CR5	Non Ageing
ISC270C	—
ISC270D	Delayed Ageing
ISC270E	Delayed Ageing
ISC270F	Non-Ageing
ISC260G	Non-Ageing
ISC340P	Non-Ageing
ISC370P	Non-Ageing
ISC390P	Non-Ageing
ISC440P	Non-Ageing
ISC270B	Delayed Ageing
ISC300B	Delayed Ageing
ISC320B	Delayed Ageing
ISC340B	Delayed Ageing
ISC370B	Delayed Ageing
ISC400B	Delayed Ageing
ISC440B	Delayed Ageing
ISC280R	—
ISC320R	—
ISC360R	—
ISC390R	—
ISC340W	—
ISC370W	—
ISC390W	—
ISC440W	—

### NOTES

1 (—) → Non-ageing guarantee is not applicable

2 For grades where non ageing guarantee is not applicable, type of non-ageing characteristics can be mutually agreed to between the manufacturer and the purchaser, before placing the order.

supplied in delayed ageing and non-ageing guarantee shall be supplied only in fully aluminium killed or in a fully stabilized condition

## 7 CHEMICAL COMPOSITION

**7.1** The ladle analysis of steel, when carried out either by the methods specified in relevant parts of IS 228 or any other established international instrumental/chemical method, shall be as given in Table 3. In case of any dispute, the procedure given in relevant parts of IS 228 shall be the referee method.

**Table 3 Chemical Composition**  
(Clauses 7.1 and 7.3)

<b>Grade</b>	<b>C</b> percent, <i>Max</i>	<b>Mn</b> percent, <i>Max</i>	<b>S</b> percent, <i>Max</i>	<b>P</b> percent, <i>Max</i>
(1)	(2)	(3)	(4)	(5)
CR0	0.35	4.00	0.035	0.05 <sup>1)</sup>
CR1	0.15	1.00	0.035	0.080
CR2	0.12	0.50	0.035	0.040
CR3	0.10	0.45	0.030	0.025
CR4	0.08	0.45	0.030	0.020
CR5	0.06	0.25	0.020	0.020
ISC270C	0.12	0.50	0.035	0.040
ISC270D	0.10	0.45	0.030	0.025
ISC270E	0.08	0.40	0.030	0.020
ISC270F	0.06	0.25	0.020	0.020
ISC260G	0.01	0.20	0.020	0.020
ISC340P	0.01	0.80	0.025	0.080
ISC370P	0.01	1.00	0.025	0.100
ISC390P	0.01	1.60	0.025	0.100
ISC440P	0.01	1.60	0.025	0.120
ISC270B	0.04	0.80	0.020	0.080
ISC300B	0.04	0.80	0.020	0.080
ISC320B	0.04	0.80	0.020	0.080
ISC340B	0.04	1.00	0.020	0.100
ISC360B	0.04	1.20	0.020	0.100
ISC390B	0.04	1.20	0.020	0.120
ISC440B	0.04	1.40	0.020	0.120
ISC280R	0.10	0.60	0.030	0.100
ISC320R	0.10	0.80	0.030	0.100
ISC360R	0.12	1.00	0.030	0.100
ISC400R	0.12	1.20	0.030	0.100
ISC340W	0.12	0.90	0.030	0.050
ISC370W	0.15	1.30	0.030	0.050
ISC390W	0.20	1.50	0.030	0.050
ISC440W	0.20	1.70	0.030	0.050

**NOTES**

**1** Restricted chemistry can be mutually agreed to between the purchaser and the manufacturer.

**2** When the steel is aluminium killed, the total aluminium content shall not be less than 0.02 percent. When the steel is silicon killed, the silicon content shall not be less than 0.10 percent. When the steel is aluminium silicon killed, the silicon content shall not be less than 0.03 percent and total aluminium content shall not be less than 0.01 percent. If mutually agreed to between the purchaser and the manufacturer, for aluminium killed steel, aluminium content can be less than 0.02 percent.

**3** For grades where non-ageing characteristics are defined, Nitrogen content shall be 0.007 percent maximum. For grades, where non-ageing characteristics are not defined, Nitrogen content shall be 0.012 percent maximum. This shall be ensured by the manufacturer by occasional check analysis.

**4** The steel can be made with micro alloying elements like Chromium, Nickel, Niobium, Vanadium, Titanium, Molybdenum, Boron, Calcium and others, either added individually or in combination,. However in case of boron, the limit shall be 0.006 percent maximum.

<sup>1)</sup> Phosphorus limit of 0.12 percent maximum can be added and in such cases, carbon content shall be limited to 0.15 percent maximum.

**7.2** Alternatively, the method specified in relevant ISO standard may be used.

**7.3 Product Analysis**

Permissible variation in the case of product analysis from the limits specified in Table 3 shall be as given in Table 4.

**8 MECHANICAL AND PHYSICAL PROPERTIES****8.1 Tensile Test**

**8.1.1** Tensile shall be carried out only, if specified by the purchaser.

**8.1.2** When specified, tests shall be carried out in accordance with IS 1608 and mechanical properties

**Table 4 Variation in Product Analysis**  
(Clause 7.3)

Element	Specified Chemical Composition Limit, Max	Variation over Specified Limit, Percent, Max
(1)	(2)	(3)
Carbon	$\leq 0.15$ $> 0.15$	0.02 0.03
Manganese	$\leq 0.60$ $> 0.60$ to $\leq 1.15$ $> 1.15$	0.03 0.04 0.05
Sulphur	$\leq 0.050$	0.005
Phosphorus	$\leq 0.050$ $> 0.050$	0.005 0.010
Silicon	$\leq 0.60$ $> 0.60$	0.03 0.06
Micro Alloy	—	Subject to negotiation

NOTE — For carbon content less than 0.10 percent, variation over specified limit can be mutually agreed to between the purchaser and the manufacturer.

shall conform to the requirements specified in Table 5A, 5B and 5C.

**8.1.3** Tensile test values apply to the direction mentioned in Table 5A, 5B and 5C. Strips having a width of 250 mm and below shall be tested longitudinally.

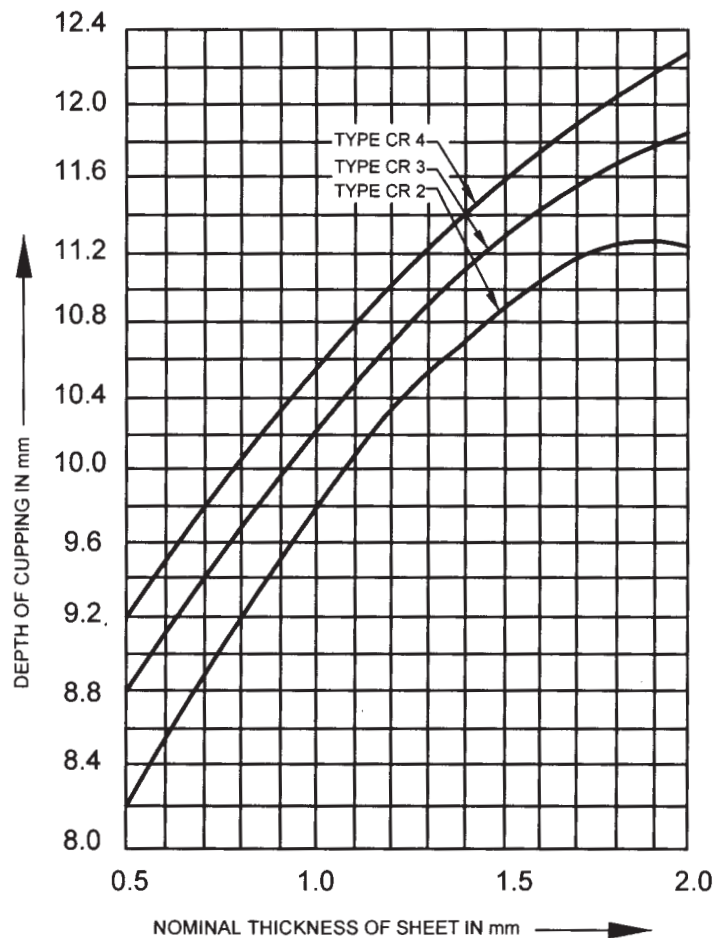
**8.1.4** The yield stress values apply to the 0.2 percent proof stress, if the yield stress is not clearly distinctive, otherwise the values apply to the lower yield stress.

**8.1.5** The values specified in Table 5A, 5B and 5C are applicable as per the non-ageing guarantee mentioned in Table 2.

## 8.2 Cupping Test

- Cupping test shall be applicable only for sheets and strips of CR2, CR3, CR4 grades having thickness from 0.5 mm up to 2.0 mm;
- Cupping test shall be carried out in accordance with IS 10175, and the minimum Erichson cupping test values shall be as given in Fig.1; and

NOTE —The shape of the cup fracture may be as mutually agreed between the manufacturer and purchaser.



**FIG. 1 MINIMUM ERICHSEN VALUES**

**Table 5A Mechanical Properties at Room Temperature in as Delivered Condition  
(Cut Lengths and Coils)**  
(Clauses 8.1.2, 8.1.3, 8.1.5, 8.5.2 and 8.6.2)

Designation (1)	Grade (2)	Yield Point or Proof Stress MPa, <i>Max</i> (3)	Tensile Strength MPa, <i>Max</i> (4)	Minimum Elongation		Mean Plastic Strain Ratio <i>r</i> -Bar (7)	Tensile Strain Hardening Component <i>n</i> -Value (8)	Test Direction (9)
				Gauge Length- 80 mm (5)	Gauge Length- 50 mm (6)			
General Purpose	CR1	280	410	27	28	—	—	T
	CR2	240	370	30	31	—	—	T
	CR3	220	350	34	35	1.3 min	0.16 min	T
	CR4	210	350	36	37	1.4 min	0.19 min	T
	CR5	190	350	38	40	1.7 min	0.22 min	T

NOTES for Table 5A

- 1 1 N/mm<sup>2</sup> = 1 MPa.
- 2 Stricter mechanical properties requirement may be agreed to between the manufacturer and the purchaser, before placing the order.
- 3 Mechanical properties apply only to annealed followed by skin-passed products.
- 4 The values of yield stress are the 0.2 percent proof stress for products which do not represent a marked yield point and the lower yield stress for the others.
- 5 Test Piece Direction – L : Rolling Direction, Test Piece Direction – T: Perpendicular to rolling direction.
- 6 For thickness upto and less than 0.6 mm, elongation values given in the table shall be reduced by 1.
- 7 *r*-Bar and *n*-Value are only applicable to thickness greater than 0.5 mm. For thickness more than 1.00 mm, *r*-bar/*r*-90 value is reduced by 0.10. For thickness greater than 2.0 mm, *r*-Bar value is reduced by 0.2 and *n*-value reduced by 0.02.
- 8 Mechanical properties are not generally tested on CR1 Grade and values mentioned are for information only.
- 9 *r*-bar and *n*-values may be modified or excluded from this requirement, by agreement between manufacturer and purchaser.
- 10 Grade CR1 may be supplied in any of the temper grades as mentioned and mechanical properties (for temper other than annealed and skin passed) may not apply and shall be as per mutual agreement between Manufacturer and purchaser before placing of an order.
- 11 Only hardness values are applicable to Grade CR0 – which is supplied in as cold rolled condition.
- 12 (—) → Not required.



**Table 5B Mechanical Properties at Room Temperature in as Delivered Condition**  
**(Cut Lengths and Coils)**  
*(Clauses 8.1.2, 8.1.3, 8.1.5, 8.5.2 and 8.6.2)*

Grade	Minimum Tensile Strength MPa	Yield Point or Proof Stress MPa				Elongation, percent Gauge Length- 50 mm									Amount of Bake Hardening BH MPa	Test Piece Direction	Mean Plastic Strain Ratio $r$ -Bar	Strain Hardening Component $n$ -Value
		Thickness, $t$ , mm				Thickness, $t$ , mm												
		$t < 0.40$	$0.40 \leq t < 0.80$	$0.80 \leq t < 1.00$	$t \geq 1.00$	$t < 0.40$	$0.40 \leq t < 0.60$	$0.60 \leq t < 0.80$	$0.80 \leq t < 1.00$	$1.00 \leq t < 1.20$	$1.20 \leq t < 1.60$	$1.60 \leq t < 2.00$	$2.00 \leq t < 2.50$	$t \geq 2.50$				
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)
ISC270C	270	155-275	145-265	135-255	125-245	37-46	37-46	38-47	39-48	40-49	41-50	42-53	43-55	44-57	—	L	—	—
ISC270D	270	—	135-225	125-215	115-205	40-49	40-49	41-50	42-51	43-52	44-53	45-55	46-57	47-59	—	L	$\geq 1.2^{1)}$	$\geq 0.15^{1)}$
ISC270E	270	—	130-205	120-195	110-185	42-50	42-50	43-51	44-52	45-53	46-54	47-56	48-58	49-60	—	L	$\geq 1.4^{1)}$	$\geq 0.18^{1)}$
ISC270F	270	—	120-185	110-175	100-165	44-52	44-52	45-53	46-54	47-55	48-56	49-58	50-60	—	—	L	$\geq 1.6$	$\geq 0.20$
ISC260G	260	—	110-175	100-165	90-165	46-54	46-54	47-55	48-56	49-57	50-58	51-60	52-62	—	—	L	$\geq 1.8$	$\geq 0.22$
ISC340P	340	—	165-255	155-245	145-235	—	35-45	36-46	37-47	38-48	39-49	$\geq 40$		—	—	T	$\geq 1.4$	$\geq 0.20$
ISC370P	370	—	175-265	165-255	155-245	—	33-43	34-44	35-45	36-46	37-47	$\geq 38$		—	—	T	$\geq 1.4$	$\geq 0.18$
ISC390P	390	—	205-305	195-295	185-285	—	31-42	32-43	33-44	34-45	35-46	$\geq 36$		—	—	T	$\geq 1.4$	$\geq 0.16$
ISC440P	440	—	245-355	235-345	225-335	—	28-39	29-40	30-41	31-42	32-43	$\geq 33$		—	—	T	$\geq 1.3$	$\geq 0.15$
ISC270B	270	—	135-225	125-215	115-205	—	40-50	41-51	42-52	43-53	44-54	$\geq 45$		—	$\geq 30$	L	$\geq 1.4$	$\geq 0.18$
ISC340B	340	—	185-285	175-275	165-265	—	34-44	35-45	36-46	37-47	38-48	$\geq 39$		—	$\geq 30$	T	$\geq 1.1$	$\geq 0.15$
ISC440B	440	—	265-375	255-365	245-355	—	26-37	27-38	28-39	29-40	30-41	$\geq 30$		—	$\geq 30$	T	$\geq 1.0$	$\geq 0.12$
ISC340W	340	—	185-285	175-275	165-265	—	33-43	34-44	35-45	36-46	37-47	$\geq 38$			—	T	—	—
ISC370W	370	—	205-305	195-295	185-285	—	30-40	31-41	32-42	33-43	34-44	$\geq 35$			—	T	—	—
ISC390W	390	—	245-355	235-345	225-335	—	29-40	30-41	31-42	32-43	33-44	$\geq 34$			—	T	—	—
ISC440W	440	—	285-390	275-380	265-370	—	26-38	27-39	28-40	29-41	30-42	$\geq 31$			—	T	—	—

**Table 5C Mechanical Properties at Room Temperature in as Delivered Condition**  
**(Cut Lengths and Coils)**  
*(Clauses 8.1.2, 8.1.3, 8.1.5, 8.5.2 and 8.6.2)*

Grade	Minimum Tensile Strength MPa	Yield Point or Proof Stress MPa			Elongation, percent Gauge Length- 80 mm			Amount of Bake Hardening MPa BH	Test Piece Direction	Plastic Strain Ratio ( <i>r</i> -90)	Strain Hardening Component ( <i>n</i> -90)
		Thickness, <i>t</i> , mm			Thickness, <i>t</i> , mm						
		<i>t</i> ≤ 0.50	0.50< <i>t</i> ≤0.70	<i>t</i> > 0.70	<i>t</i> ≤ 0.50	0.50< <i>t</i> ≤0.70	<i>t</i> > 0.70				
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
ISC300B	300	180-250	180-230	180-230	≥30	≥32	≥34	≥35	T	≥1.6	≥0.17
ISC320B	320	220-290	220-270	220-270	≥28	≥30	≥32	≥35	T	≥1.5	≥0.16
ISC360B	360	260-340	260-320	260-320	≥25	≥27	≥29	≥35	T	—	—
ISC390B	390	300-380	300-360	300-360	≥22	≥24	≥26	≥35	T	—	—
ISC280R	280	180-250	180-230	180-230	≥30	≥32	≥34	—	T	—	—
ISC320R	320	220-290	220-270	220-270	≥28	≥30	≥32	—	T	—	—
ISC360R	360	260-340	260-320	260-320	≥25	≥27	≥29	—	T	—	—
ISC400R	400	300-380	300-360	300-360	≥22	≥24	≥26	—	T	—	—

NOTES for Table 5B and 5C

- 1 1 N/mm<sup>2</sup> = 1 MPa = 0.102 0 kgf/mm<sup>2</sup>.
- 2 Stricter mechanical properties requirement may be agreed to between the manufacturer and the purchaser, before placing the order.
- 3 Mechanical properties apply only to annealed followed by skin-passed products
- 4 The values of yield stress are the 0.2 percent proof stress for products which do not represent a marked yield point and the lower yield stress for the others
- 5 *r*-Bar/*r*-90 and *n*-Value/*n*-90 are only applicable to thickness greater than 0.5 mm. For thickness more than 1.00 mm, *r*-bar/*r*-90 value is reduced by 0.10. For thickness greater than 2.0 mm, *r*-Bar/*r*-90 value is reduced by 0.2 and *n* value/*n*-90 reduced by 0.02.
- 6 Test Piece Direction – L : Rolling Direction, Test Piece Direction – T: Perpendicular to rolling direction.
- 7 Any additional test may be carried out as per mutual agreement between the manufacturer and the purchaser.
- 8 <sup>1)</sup>Not a mandatory requirement and it can be applied only on mutual agreement.
- 9 *Choice of Properties*: Properties are applicable as per thickness range provided in Table 5B & 5C. If mutually agreed to between the manufacturer and the purchaser and properties range (yield point or proof stress and elongation) is not required as per thickness range, then minimum and maximum values of the respective grade (yield point or proof stress and elongation), shall be considered as limits of yield point or proof stress and elongation. For example: In Grade ISC270C, properties are not required as per thickness range, then limits of yield point or proof stress: 125-275 MPa and elongation : 37-57 percent.
- 10 (–) → Not required.

- c) Cupping test is not a mandatory requirement for this standard. The same can be applied with mutual agreement between the manufacturer and the purchaser.

### 8.3 Hardness Test

Cold rolled sheets and strips shall conform to the hardness requirements specified in Table 6, when tested in accordance with IS 1586. However, by way of departure from these standards, a visible deformation on the back side of the specimen is permitted. The values determined in this way shall be identified by using symbols HRBm and HR30Tm, so as to differentiate these from the hardness values determined on thicker products (which are not allowed to exhibit a visible deformation on the back side of the specimen). If agreed between the manufacturer and the purchaser, hardness can be checked by using IS 1501 for metallic material and results as agreed to between the manufacturer and the purchaser.

**Table 6 Hardness of Grade at Room Temperature**  
(Clause 8.3)

Grade (1)	Temper (2)	Hardness (HRB)	
		Min (3)	Max (4)
CR0	Cold Rolled Full Hard	85	—
CR1	Half Hard(1/2H)	75	90
CR1	Quarter Hard(1/4H)	60	80
CR1	1/8 Hard(1/8H)	50	71
CR1	Annealed (A) Dead Soft	—	68
CR1	Skin passed	—	70

#### NOTES

1 Stricter hardness ranges can be as agreed to between the manufacturer and the purchaser.

2 Equivalent vickers hardness values are allowed on agreement between the interested parties at the time of ordering. The hardness of sheet thinner than 0.6mm shall be measured exclusively in compliance with HR 30T scale.

### 8.4 Bend Test

**8.4.1** Bend test shall be carried out in accordance with IS 1599.

**8.4.2** The angle of bend and the internal diameter for the different grades of material shall be as given in Table 7.

**Table 7 Bend Test**  
(Clause 8.4.2)

Minimum Tensile Strength (MPa) (1)	Bend Angle (2)	Bend Radius (3)
270	180°	Close
340	180°	Close
370	180°	Close
390	180°	Close
440	180°	Close

NOTE — For grades, where minimum tensile requirement is not mentioned in the above table, nearest minimum tensile strength value can be applied. For Grade CR1, angle of bend degree is 180° and bend radius is  $t$  ( $t$  = thickness).

**8.4.3** The axis of the bend shall be in the direction of rolling. The test pieces shall be deemed to have passed the test, if the outer convex surface is free from cracks.

**8.4.4** Bend test is not a mandatory requirement for this standard. The same can be applied with mutual agreement between the manufacturer and the purchaser.

### 8.5 Plastic Strain Ratio ( $r$ bar/ $r$ -90)

**8.5.1** The plastic strain ratio is an index of drawability ( $r$  bar/ $r$ -90), shall be applicable only to thickness between 0.50 mm to 2.00 mm. For thickness more than 1.00 mm,  $r$ -bar/ $r$ -90 value is reduced by 0.10 and if required, for thickness more than 2.0mm,  $r$ -bar/ $r$ -90 value to be reduced by 0.20.

**8.5.2** The plastic strain ratio shall be checked in accordance with IS 11999 and results shall conform to as given in Table 5A, 5B and 5C.

### 8.6 Tensile Strain Hardening Component ( $n$ -value)

**8.6.1** The tensile strain hardening is an index of the stretch-ability ( $n$ -value/ $n$ -90), shall be applicable only to thickness between 0.50 mm and 2.00 mm. If required, for thickness more than 2.00 mm, the  $n$ -value/ $n$ -90 is reduced by 0.02.

**8.6.2** The tensile strain hardening component shall be checked in accordance with IS 15756 and results shall conform to as given in Table 5A, 5B and 5C.

### 8.7 Bake Hardening Index – (BH)

Bake hardening index shall be tested as per Annex B and minimum BH value shall as given in Table 5B and 5C.

### 8.8 Retest

If a test does not give the specified results, two additional tests shall be carried out at random on the same lot. Both retests shall conform to the requirements of this standard; otherwise the lot shall be rejected.

## 9 SURFACE FINISH

### 9.1 Cold Reduced Steel Sheet and Strip

This product is normally supplied skin passed (see 9.2), but may be supplied annealed last (that is without skin pass), if specified by the purchaser before placing the order.

### 9.2 Skin Pass

The purpose of skin passing is one or more the following:

- To temporarily minimize the appearance of coil breaks, stretcher strains (Luder lines)

or fluting during fabrication of finished parts;

- b) To obtain the required surface finish suitable for ordinary decorative painting; and
- c) To control the shape.

Some increase in hardness and some loss in ductility will result from skin passing.

### 9.3 Strain Ageing

Cold reduced sheet and strip in qualities CR1, CR2, CR3 supplied in skin-passed condition tends to strain age and this may lead to the following:

- a) Surface markings from stretcher strains (Luder lines) or fluting when the steel is formed; and
- b) Deterioration in ductility.

Because of these factors, it is essential that the period between final processing at the mill and fabrication be kept to minimum. Rotation of stock, by using oldest material first, is important. Stocking of such sheet and strip for extended periods of time should be avoided; for optimum performance the period should not exceed six weeks.

For skin passed sheet and strip in qualities CR1, CR2, CR3 and with due regard to foregoing precautions, reasonable freedom can be achieved by effective roller levelling immediately prior to fabrication at the purchaser's plant. Freedom from stretcher strain and fluting for a period of six months or three months can be achieved by the supply of skin passed non-ageing steel or delayed ageing steel respectively. Grades of non-ageing quality shall be specified in such cases, where Luder's lines are not acceptable and where roller levelling is not possible.

### 9.4 Surface Condition

The surface condition of CR0 and CR1 grade should be that normally obtained in a cold rolled product. Grades of other quality (that is other than CR0 and CR1) are supplied either of the surface qualities A or B.

#### 9.4.1 Surface Quality A (Unexposed)

Imperfections such as pores, slight imperfections, small marks, minor scratches and slight colouring, which do not affect the formability or the application of surface coatings are permitted.

#### 9.4.2 Surface Quality B (Exposed)

The better surface shall be free of imperfections, which might affect the uniform appearance of quality coating. The other surface shall at least conform to surface quality A.

**9.4.3** Unless otherwise agreed, a single surface of the product shall comply with the specified requirements. On mutual agreement between the manufacturer and the purchaser, any one of the applicable surface or both the surfaces (For Strip — Outside/Inside Surface, For Sheet — Top/Bottom Surface) shall comply with the requirements.

**9.4.4** The other surface shall be such that during subsequent treatment it does not have a deleterious effect on the better surface.

### 9.5 Surface Finish

**9.5.1** Cold reduced steel sheet and strip may be supplied in a Bright finish and matt finish, dull in appearance, which is suitable for ordinary decorative painting but is not recommended for electro plating. Surface roughness may be given subject to mutual agreement between the manufacturer and the purchaser.

**9.5.2** When cold reduced sheet and strip is deformed during fabrication, localized areas may roughen to some degree and such affected portions of the part may require hand finishing to prepare the surface for the intended application.

**9.5.3** Designation of surface finish shall be as per Table 8.

**Table 8 Surface Finish**  
(Clause 9.5.3)

Surface Finish Class (1)	Surface Finish Designation (2)	Surface Roughness ( $\mu\text{m}$ ) (3)
Dull Finish	D	$0.50 \leq R_a \leq 2.00$
	C	$0.50 \leq R_a \leq 1.20$
Bright Finish	B	$R_a \leq 0.60$

#### NOTES

1 Surface roughness  $R_a$  is the average roughness in accordance with IS 15262.

2 Restricted range of surface roughness can be agreed to between the manufacturer and the purchaser.

3 Unless and otherwise mentioned, general condition of surface shall be dull finish with surface designation D.

### 9.6 Oiling

As a deterrent to rusting, a coating of oil is usually applied to the product. The oil is not intended as a drawing or forming lubricant and should be easily removable with degreasing chemicals. The product may be ordered not oiled, if required, in which case, the supplier has no responsibility, if oxidation occurs. For type of oiling, Table 9 can be referred (Reference purpose only).

**Table 9 Type of Oiling**  
(Clause 9.6)

Type of Oiling		Description
(1)	(2)	(3)
Normal rust preventive oil		Commonly used for steel strip and sheet for rust prevention
Special rust preventive oil	High lubrication rust preventive oil	For rust prevention and better frictional properties during press work
	Solid lubricant	
No oiling		Surface will be dry and prone to oxidation

NOTE — Above table for the purpose of reference only.

## 10 FREEDOM FROM DEFECTS

**10.1** The finished sheets and strips shall be reasonably free from harmful defects such as scale, rust, blisters, laminations, pitting, porosity, cracked or torn edges or any other defects which are harmful to the intended use.

**10.2** The degree or amount of surface defects in a strip may be expected to be more than in cut lengths because of the impossibility of rejecting portions of a strip. The purchaser should take this into account and the percentage of admissible defects may be agreed at the time of the enquiry and order.

**10.3** The sheets shall be reasonably flat and edges cleanly sheared and squared to the specified dimensions.

## 11 DIMENSIONS AND TOLERANCES

**11.1** Unless and otherwise agreed to between the manufacturer and the purchaser, standard dimensions of cold rolled sheets and strips shall be as given below:

Thickness, mm = 0.08, 0.10, 0.12, 0.14, 0.16, 0.18, 0.20, 0.22, 0.25, 0.28, 0.30, 0.32, 0.35, 0.40, 0.45, 0.50, 0.55, 0.63, 0.70, 0.80, 0.90, 1.00, 1.20, 1.25, 1.40, 1.50, 1.60, 1.80 and 2.00

The following are the preferred thickness for sheets and strips above 2.00 mm:

Thickness, mm = 2.50 mm, 2.65 mm, 3.00 mm, 3.25 mm, 3.50 mm and 4.00 mm.

**11.2** Dimensional and shape tolerances applicable to cold rolled sheets and strip shall be as given in IS/ISO 16162. Stricter dimensional tolerances can be agreed to between the manufacturer and the purchaser.

**11.3** For untrimmed edges, width tolerances shall be  $^{+2\text{mm}}_{-0}$  and for edges which are trimmed before cold rolling, width tolerances shall be  $^{+7\text{mm}}_{-0}$ . For edges trimmed after cold rolling and annealing, width tolerances shall be as per ISO 16162.

## 12 SAMPLING AND TESTS

**12.1** One representative sample from a strip or a lot of sheets shall be taken for tensile testing. A lot consists of 50 tonnes or less of sheets or strips of the same quality rolled to same thickness and processed in same condition. If the lot consists of more than one heat, samples from each heat shall be tested.

**12.2** For cupping, hardness and bend tests, one sample from each lot of 50 tonnes of same heat or part thereof or one sample from each coil shall be taken.

**12.3** The specimens shall not undergo any treatment on either surface before testing. In case of strips, samples shall be taken from the beginning or end of the strip.

**12.4** The centre of each test piece shall be at a quarter widths. When it is not feasible, however the sampling should be made as close to the aforementioned position as possible.

## 13 MARKING

### 13.1 Marking

The following shall be legibly marked or printed on a sticker attached on the top of each bundle of package of sheets / on a tag attached to each coil:

- Manufacturer's name or trade-mark;
- Quality designation and grade;
- Product dimensions;
- Cast or identification mark by which the sheet or strip may be traced to cast or casts from which they were made; and
- Mass/Net weight.

### 13.2 BIS Certification Marking

The material may also be marked with the Standard Mark.

**13.2.1** The use of the Standard Mark is governed by the provisions of the *Bureau of Indian Standards Act*, 1986 and the Rules and Regulations made thereunder. The details of conditions under which the licence for the use of Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

### 13.3 Packing

- Each sheet shall be treated on both sides with non-hardening type rust preventive oil, which can be easily washed with aqueous alkali solution;
- Sheets and strips shall preferably be supplied in bundles or packages not more

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than 3 tonnes or as agreed to between the purchaser and the manufacturer; and

- c) Sheets and strips shall be securely packed in water-resistant material and covered all

over with steel envelope and securely tied round with steel straps, preferably with wooden battens underneath to prevent the sheets from rusting and damage during transit.

**ANNEX A**  
(Foreword)

**CORRELATION OF OLD AND NEW GRADES/DESIGNATIONS**

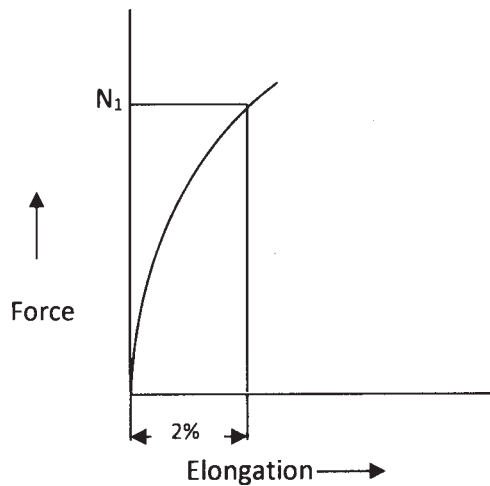
<i>Old Designation</i>		<i>New Designation</i>	
Grade (1)	Name (2)	Name (3)	Grade (4)
CR0	Hard	Cold Rolled (Full Hard)	CR0
CR1	Commercial	General Purpose — Commercial	CR1
CR2	Drawing	General Purpose — Drawing	CR2
CR3	Deep Drawing	General Purpose — Deep Drawing	CR3
CR4	Extra Deep Drawing	General Purpose — Extra Deep Drawing	CR4
CR5	Extra Deep Drawing (Stabilized Interstitial Free)	General Purpose — Extra Deep Drawing (Stabilized Interstitial Free)	CR5
CR5-IF340	Extra Deep Drawing (Stabilized Interstitial Free)	Interstitial Free — High Strength steel	ISC340P
CR5-IF390	Extra Deep Drawing (Stabilized Interstitial Free)	Interstitial Free — High Strength steel	ISC390P
CR5-IF440	Extra Deep Drawing (Stabilized Interstitial Free)	Interstitial Free — High Strength steel	ISC440P
CR5-BH270	Extra Deep Drawing (Stabilized Interstitial Free)	Bake Hardening	ISC270B
CR5-BH320	Extra Deep Drawing (Stabilized Interstitial Free)	Bake Hardening	ISC320B
CR5-BH370	Extra Deep Drawing (Stabilized Interstitial Free)	Bake Hardening	ISC370B

## ANNEX B (Clause 8.7)

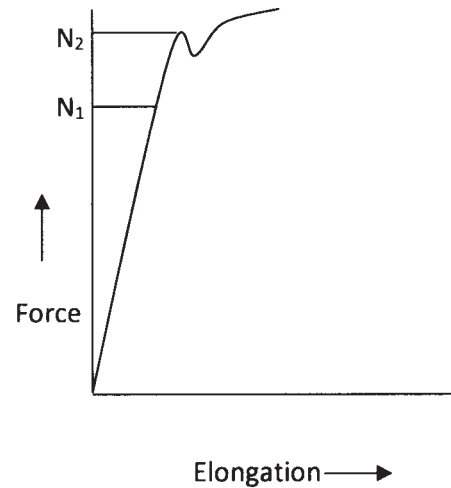
### BAKE HARDENING TEST

The bake hardening index (BH) is the increase in the yield point that is found in the bake hardening test carried out. Bake hardening of steel is achieved during the paint baking treatment. The test procedure for the determination of bake hardening index is as follows:

- a) Test specimen shall be collected from annealed and skin passed material, which is not supposed to exhibit yield point phenomenon during tensile testing, in the direction mentioned as per Table 5B and 5C. Tensile specimen to be prepared as per IS 1608
- b) Parallel portion area of the test piece shall noted be as  $A_0$ .
- c) The test specimen shall be strained to 2 percent tensile elongation. The corresponding force shall be noted as  $N_1$ .
- d) The specimen shall be unloaded and heated for 20 min at a temperature of 170°C.
- e) After the heat treatment, the test specimen shall be subjected to tensile testing again. The sharp yield point is expected to appear along with the yield drop phenomenon. The force corresponding to the upper yield point shall be noted as  $N_2$ .
- f) The BH value calculation shall be obtained as  $BH = (N_2 - N_1)/A_0$
- g) BH Value calculation is schematically represented in Fig. 2A and 2B.



2A Preliminary strain loading



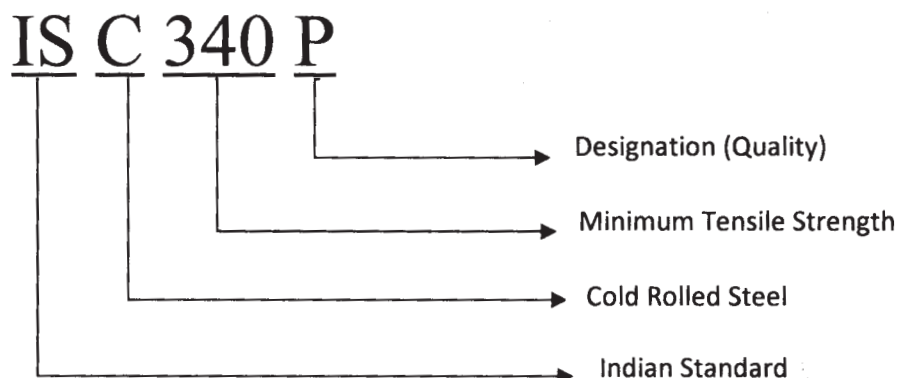
2B After heat treatment

FIG. 2 BAKE HARDENING

## ANNEX C

(Table 1 Note 3)

### NOMENCLATURE OF GRADE







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